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ABSTRACT

This report examines the construct validity of the Ball Aptitude Battery (BAB), a multiple ability test battery designed to measure aptitudes related to successful work behavior. Construct validation has focused attention on the role of psychological theory and on the need to formulate hypotheses that can be examined in the validation process. Evidence of construct validity arises from several sources, and this paper summarizes existing evidence from concurrent validation and factor analytic studies of the BAB. A multimethod-multitrait approach comparing the BAB with the Comprehensive Ability Battery and the Differential Aptitude Tests is reported. Each test from the three batteries was classified into one of 10 aptitude constructs derived from a previous BAB factor analysis: Grip, Finger Dexterity, Spatial, Inductive Reasoning, Analytical Reasoning, Vocabulary, Word Association, Fluency, Writing Speed, and Clerical. Correlations showed clear evidence of discriminant and convergent validity for most of the BAB aptitudes. (Author/BS)

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TECHNICAL REPOR

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BALL FOUNDATIO

Technical Report No. 9

THE CONSTRUCT VALIDITY OF THE BALL APTITUDE BATTERY

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Abstract

The present paper examines the construct validity of the Ball Aptitude Battery (BAB), a multiple aptitude test battery. Construct validation has focused attention on the role of psychological theory and on the need to formulate hypotheses that can be examined in the validation process. Evidence of construct validity arises from several sources, and this paper summarizes existing evidence from concurrent validation and factor analytic studies of the BAB. A multimethod-multitrait approach comparing the BAB with the Comprehensive Ability Battery and the Differential Aptitude Tests is reported in detail; verification of four theoretical expectations about the construct of aptitude is also reported.

The Construct Validation of the Ball Aptitude Battery[1]

The Ball Aptitude Battery (BAB) is a multiple-ability test battery designed to measure aptitudes related to successful work behavior in both training programs and job positions. High school students as well as students in apprenticeship trade programs have used the battery of tests for vocational planning and decision making.

The practical utility of the test battery has been previously demonstrated by Dohm and Sung (1980) and Sung and Dawis (1981a) in a series of concurrent validity studies. In the Dohm and Sung study, the BAB tests were correlated with the grades of over 500 high school students in 10 subject areas. In general, Vocabulary was found to be the best predictor across all subjects, followed by Analytical Reasoning, Ideaphoria, and Clerical. Each of these tests correlated .30 or higher with overall GPA.

Dohm and Sung (1980) further reported data comparing differences among sex and ethnic groups in the utility of the BAB tests as predictors of high school performance. Predictive utility for the BAB tests was demonstrated for both sexes as well as for black, hispanic, and white ethnic groups. The BAB tests were correlated with overall GPA.

Furthermore, Dohm and Sung (1980) reported that when multiple regression was employed for a sample of 801 high school students,

it was found that a combination of three or four BAB tests could predict grades in English ($\underline{R}$ = .48), Math ($\underline{R}$ = .34), and Science ($\underline{R}$ = .45). A multiple correlation of .54 was obtained when the BAB tests of Vocabulary, Clerical, Ideaphoria, and Paper Folding had been combined to predict overall GPA.

In addition to predicting academic criteria, Sung and Dawis (1981a) performed a multiple discriminant analysis using the BAB to predict actual occupational memberships in five occupations: certified public accountants, elementary school teacher, commercial airline pilots, bank tellers, and carpenters. The discriminant analyses correctly classified 78.1 per cent.

In summary, the BAB has been demonstrated to be a practical tool in academic guidance and in occupational classification placement. However, psychological instruments have basically two kinds of validity: theoretical and practical.

A theoretical validity question can be posed as such: Is the instrument a good measure of the construct or trait? Any relevant data that sheds light on the nature of the construct under consideration and the conditions affecting its development and manifestations is of theoretical importance and contributes to the process of construct validation of a test.

If tests are to be truly measures of ability, several theory-derived expectations can be stated that would help explicate our

theory regarding ability constructs:

1. The test should measure only a single ability;

2. The measure should be independent of (uncorrelated with) measures of other abilities;

3. The measure should be minimally associated with demographic factors such as sex or ethnic group affiliation; and

4. The measure should yield high correlations with other purported measures of the same ability and likewise yield near zero correlations with purported measures of other abilities. Campbell and Fiske (1959) refer to the former as convergent validity and the latter as divergent validity.

The verification of these four expectations help confirm the theoretical understanding of the ability constructs proposed here and contributes to the construct validation of the Ball Aptitude Battery.

Relative to the first two expectations, Sung and Dawis (1981a) have shown through a series of factor analyses of the BAB for different sex and race groups that most BAB tests clearly loaded on only one factor. In most instances, the test's largest loading accounted for over half of the communality. The same procedure was followed for each group: a principal factor solution with iteration to obtain the final communality estimates, followed by a varimax orthogonal rotation. Interestingly, the separate sex

and race groups showed highly similar factor structures, despite pronounced socioeconomic differences among the race groups (Sung & Dawis, 1981).

The third expectation was achieved since for all the BAB tests except Vocabulary, 10 per cent or less of the variance (as indicated by R^2) was associated with the demographic factors of sex, age, race, and education (Sung & Dawis, 1981a).

Data related to the fourth expectation was studied and presented here. We may assume that adequate construct validity of the BAB exists if the fourth expectation is met, since research data exists which supports the first three expectations. Furthermore, the concurrent validity of the BAB using academic and occupational relevant criteria is well established.

Method

Instrumentation

The 14 ability variables involved in this study were measured with the Ball Aptitude Battery (BAB; Sung & Dawis, 1981a; Sung, Dawis, & Dohm, 1981).

The 14 tests which were administered in the order given below may be described as follows:

1. Clerical Test (C): Measures the ability to perceive visual details, similarities and differences.

2. Idea Fluency (IF): Measures the ability to produce ideas of alternative uses of a given object.

3. Inductive Reasoning (IR): Measures the ability to identify a rule, to reason from specific information to a general principle.

4. Word Association (WA): Measures the similarity of response to the normative word association response.

5. Writing Speed (WS): Measures the ability to write fast.

6. Paper Folding (PF): Measures the ability to visualize in two-dimensional space.

7. Vocabulary (V): Measures the ability to choose the righ word that represents an idea.

8. Ideaphoria (IP): Measures the ability to generate a rapid and abundant flow of words and ideas.

9. Finger Dexterity-Left (FL): Measures the ability of the left hand to make skillfully controlled manipulations of small objects, principally involving finger movement.

10. Finger Dexterity-Right (FR): Same for the right hand.

11. Grip-Left (GL): Measures the strength of grip of the left hand.

12. Grip-Right (GR): Same for the right hand.

13. Shape Assembly (SA): Measures the ability to visualize in three-dimensional space.

14. Analytical Reasoning (AR): Measure the ability to reason from a general principle to specific information and from specific examples to a general principle, and the ability to organize related concepts in a systematic manner.

For comparative purposes, two additional aptitude batteries were employed, The Comprehensive Ability Battery (CAB) and the Differential Aptitude Tests (DAT).

The 20 tests of the CAB were each designed to measure a single ability factor (Hakstian & Cattell, 1976). The tests included in the CAB are as follows: Verbal Ability (V), Numerical Ability (N), Spatial Ability (S), Speed of Closure (Cs), Perceptual Speed and Accuracy (P), Inductive Reasoning (I), Flexibility of Closure (Cf), Associative Memory (Ma), Memory Span (Ms), Meaningful Memory (Mm), Spelling (Sp), Auditory Ability (A), Esthetic Judgement (E), Spontaneous Flexibility (Fs), Ideational Fluency (Fi), Word Fluency (W), Originality (O), Aiming (A), Representative Drawing (RD).

The Differential Aptitude Tests (DAT) are a collection of eight tests developed by Bennet, Seashore, and Wesman (1974). The tests are Verbal Reasoning, (VR), Numerical Ability (NA), Abstract Reasoning (AR), Clerical Speed and Accuracy (CSA), Mechanical Reasoning (MR), Space Relations (SR), Spelling (Sp), and Language Usage (Lu).

Subjects

Several subject pools were utilized to generate the data needed. The intercorrelations of the BAB were based on a sample of 801 high school seniors from public and private schools in Texas and Illinois. The BAB-DAT correlations were obtained from a subsample of 84 subjects who had taken both batteries.

Six-week test-retest reliabilities for the BAB were obtained from a sample of 261 subjects who were tested by The Ball Foundation. The reliability of the BAB Vocabulary test was assessed by the alternate form method using the same sample.

A sample of 147 subjects who were tested at The Ball Foundation was the basis for generating the BAB-CAB correlations.

Data Analysis

After a preliminary examination of item content and test definition provided by the publishers, each test from the three batteries was classified into one of 10 aptitude constructs. The 10 aptitude groupings were obtained from a previous factor analysis of the BAB (Sung & Dawis, 1981b). The 10 aptitudes considered were Grip, Finger Dexterity, Spatial, Inductive Reasoning, Analytical Reasoning, Vocabulary, Word Association, Fluency, Writing Speed, and Clerical. Some tests of the CAB and DAT could not be conveniently classified into the above aptitude groupings.

The classification of aptitudes described above permitted a visual grouping of tests purported to measure the same aptitude construct. Correlation coefficients were computed for each pair of tests and were interpreted relative to convergent and discriminant validity.

Since the primary focus of the study is to establish the construct validity of the BAB, and since two different subject pools were used, no intercorrelations were computed for the CAB or DAT, nor were any CAB-DAT correlations obtained.

Results and Discussion

The multimethod-multitrait correlation matrix of the BAB, DAT, and CAB is presented in Table 1.

Insert Table 1 about here

A discussion of each aptitude construct will be presented separately.

1. Grip: The BAB aptitude does not have a comparable counterpart on the CAB or DAT. Thus convergent validity can only be inferred from the high interrelationship between the two parts of the BAB. The low correlations obtained when the Grip tests are paired with other tests is a clear evidence of discriminant validity.

2. Finger Dexterity: Convergent and discriminant validity is obtained in an analogous way to the Grip tests. A component of the dexterity aptitudes is perceptual speed and accuracy which partially explains the relatively high correlation of the BAB dexterity tests with the CAB-P test.

3. Spatial: Clear support exists for the convergent and discriminant validity of the spatial aptitude. However, some of the variance of the BAB spatial measures can probably be explained by a reasoning component. A further refinement of this construct would minimize the reasoning component.

4. Inductive Reasoning: Discriminant validity is evident. Convergent validity is somewhat clouded by the relatively low correlation with the CAB-I test (r = .17) even though the correlations with the DAT counterparts are low but adequate. Perhaps the inductive reasoning and analytical reasoning aptitude constructs are not clearly separate entities.

5. Analytical Reasoning: Convergent validity is present, as well as discriminant validity. However, this aptitude is not in its purest form since it obviously picks up verbal and spatial components.

6. Vocabulary: This aptitude serves as a good construct which is supported by the data from convergent and discriminant validities. The generally higher correlations with other factors

may be indicative of the vocabulary aptitude being a good general factor.

7. Word Association: This aptitude is clearly unique and not similar to the other aptitudes (e.g., has good discriminant validity). Unfortunately, no counterpart test exists on the CAB and DAT to clearly demonstrate convergent validity.

8. Fluency: Evidence for convergent and discriminant validity exists for this aptitude. There probably exists some common component with writing speed in this aptitude.

9. Writing Speed: Data is indicative of a fluency component to this aptitude. A higher correlation should exist between this BAB aptitude and CAB-W.

10. Clerical: Evidence for both convergent and discriminant valdiity is present from BAB-CAB data. It is unclear, however, why a greater relationship does not exist between this BAB aptitude and DAT-CSA.

Overall, the findings from the multimethod-multitrait correlation matrix support the fourth expectation of the proposed theory of aptitudes. Clear evidence of discriminant and convergent validity exists for most of the BAB aptitudes. Some of the BAB aptitudes such as grip, dexterity, and to some extent the reasoning and fluency factors did not have comparable counterparts on the CAB and DAT. The process of further refinement of the constructs would be facilitated if the relationships between the BAB

and other differential test batteries such as the General Aptitude Test Battery (GATB) could be determined.

Finally, the construct validation of the BAB has been supported from the results of factor analytic studies as well as from the multitrait-multimethod approach. Support for the four theoretical expectations that had been proposed were for the most part verified for each of the proposed aptitudes. However, further refinements of the constructs would be essential for further theoretical discussion of the aptitude construct. A better theoretical understanding of the construct of aptitude will ultimately have a practical utility for educational environment in elucidating an important construct related to learning, skill acquisition, and in developing a taxonomic classification of ability. One can only imagine the potential implications this would have in restructuring future training environments.

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Footnote

[1]An earlier draft of this report was given at the annual American Psychological Association Convention in Washington, DC, August 1982.

Table 1

Multitrait-Multimethod Correlation Matrix of BAB, CAB, and DAT tests

	Ball Aptitude Battery													
Test	GL	GR	FL	FR	PF	SA	IR	AR	V	WA	IP	IF	WS	C
BAB-GL	93	91	04	-02	18	27	13	-02	-01	-06	-07	05	08	-15
BAB-GR	91	93	-05	-04	15	28	02	-00	00	-11	-07	03	-02	-11
BAB-FL	04	-05	79	49	27	11	20	13	04	09	13	23	32	-01
BAB-FR	-02	-04	49	79	07	09	10	07	-13	04	08	08	20	11
BAB-PF	18	15	27	07	85	49	46	44	45	13	35	31	29	-06
BAB-SA	27	28	11	09	49	70	25	41	30	10	12	23	-01	06
CAB-S	17	17	13	28	47	48	25	33	08	02	22	15	11	19
DAT-SR	02	00	04	04	60	47	37	45	43	08	07	13	05	13
BAB-IR	13	02	20	10	46	25	71	30	23	20	15	19	31	-05
CAB-I	01	01	07	15	33	30	17	38	20	08	28	12	13	21
DAT-AR	27	24	19	10	56	43	42	41	50	15	22	23	27	14
DAT-MR	48	49	15	01	56	61	39	53	37	05	00	08	23	-05
BAB-AR	-02	-00	13	07	44	41	30	73	55	18	29	35	09	30
DAT-VR	04	11	04	04	59	41	32	64	73	22	21	34	12	31
BAB-V	-01	00	04	-13	45	30	23	55	98	09	36	42	11	21
CAB-V	25	24	00	01	37	25	16	32	88	-00	46	43	45	24

Table 1 (cont.)

Multitrait-Multimethod Correlation Matrix of BAB, CAB, and DAT tests

	Ball Aptitude Battery													
Test	GL	GR	FL	FR	PF	SA	IR	AR	V	WA	IP	IF	WS	C
BAB-WA	-06	-11	09	04	13	10	20	18	09	64	-01	09	13	08
BAB-IP	-07	-07	13	08	25	12	15	36	29	-01	79	51	29	12
BAB-IF	05	03	23	08	31	23	19	35	42	09	51	73	20	11
BAB-Fs	-03	01	-03	-01	28	25	39	31	46	-15	28	26	34	37
BAB-Fi	27	26	06	06	32	20	11	20	55	-10	46	59	42	21
BAB-WS	08	-02	32	20	29	-01	31	09	11	13	29	20	69	-02
CAB-W	23	30	-16	-03	27	26	30	53	48	04	37	16	13	54
BAB-C	-15	-11	-01	11	-06	06	-05	30	21	08	12	11	-02	89
CAB-P	-04	-07	37	45	32	27	16	27	10	08	31	13	34	70
DAT-CSA	07	05	15	23	13	14	17	07	08	-03	06	-06	30	19
CAB-Sp	04	12	-20	-14	13	02	10	39	73	15	49	-01	41	68
DAT-Sp	-17	-11	10	10	29	03	12	30	40	07	06	02	11	50
DAT-Lu	-15	-10	02	00	48	32	32	49	59	05	11	14	-00	25
CAB-N	36	34	16	17	43	31	15	36	50	-05	44	44	42	40
CAB-Cs	-06	01	13	-11	16	-00	28	27	17	09	28	-04	17	38
CAB-Cf	12	17	07	17	40	22	24	34	45	-07	23	23	37	26
CAB-Ma	-15	-16	-25	09	02	11	10	27	24	-30	03	03	38	35

Table 1 (cont.)

Multitrait-Multimethod Correlation Matrix of BAB, CAB, and DAT tests

	Ball Aptitude Battery													
Test	GL	GR	FL	FR	PF	SA	IR	AR	V	WA	IP	IF	WS	C
CAB-Mk	53	53	01	-03	39	48	20	30	38	-02	09	40	04	-00
CAB-Ms	18	16	11	15	33	26	18	25	27	-08	35	26	31	23
CAB-Mm	04	02	06	02	27	23	36	32	27	-15	14	18	13	10
CAB-AA	22	17	-21	-08	04	10	32	23	13	-14	-02	-25	10	-00
CAB-E	-22	-20	15	04	27	53	64	41	-18	-53	-19	-09	13	01
CAB-O	23	19	09	07	20	13	20	21	40	-11	30	50	20	11
CAB-A	-09	-11	29	38	24	28	21	23	07	10	14	04	14	23
CAB-RD	19	17	17	13	23	23	19	19	25	10	13	36	27	10
DAT-NA	14	17	15	19	56	55	33	56	51	16	12	18	14	28

Note. Decimal points are omitted.